COPC: **Thallium** CAS 7440-28-0

Test Organisms: Quail (Omnivore, Order-Galliformes)
Exposure Medium: Oral in diet (bread)
Test Endpoint: FEL
Reference: Shaw, P.A., 1933, "Toxicity and deposition of thallium in certain game birds," Journal of Pharmacology and Experimental Therapeutics, 48(4):478-487.
QCE: 12 mg/kg

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Very old study, doses and effects poorly characterized, only high doses and lethal endpoints considered
Q_1	1	1	1	Ecologically relevant endpoint (lethality)
Q_2	3	3	3	Acute duration
Q_3	3	3	3	FEL for lethality
U	3	3	3	Very old study, poorly designed and analyzed
Total AF	81	162	243	R * I * Q_1 * Q_2 * Q_3 * U = Total AF
QCE (mg/kg-day)	12	12	12	QCE = quantified critical endpoint
TRV	0.15	0.07	0.05	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.15	Test organism is in the same order and trophic level as the functional group members	none
2	0.07	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.05	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

*Ingestion rate from Wildlife Exposure Factors Handbook and BW from Weimeyer article

**note-in the article the units on the 12 were just mg/kg...it was assumed that that meant kg of food.

COPC:	**Thallium** CAS 7440-28-0	
Test Organisms:	Rat (Omnivore, Order-Rodentia)	
Exposure Medium:	Oral in Diet	
Test Endpoint:	LOAEL	Hair loss
Reference:	Downs, W., Scott, J., Steadman, L., Maynard, E., 1960, "Acute and Sub-acute Toxicity Studies of Thallium Compounds", *Industrial Hygiene Journal*, pp. 399-406.	
QCE:	1.8mg/kg-day	Specified (Average between 1-3 depending on the BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of male and female rats tested, no juveniles tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic duration
Q_3	2	2	2	LOAEL
U	2	2	2	Good design, a variety of compounds tested, reproductive endpoints not examined. Compound is thallium acetate. Similar responsiveness for thallium oxide.
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	1.8	1.8	1.8	QCE = quantified critical endpoint
TRV	0.11	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.11	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: **Thallium** CAS 7440-28-0

Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Drinking Water
Test Endpoint: FEL Reduced sperm motility, etc.
Reference: Formigli, L., et al., 1986, "Thallium-induced testicular toxicity in the rat," Environmental Research, 40(2):531-539.
QCE: 0.75mg/kg-day Daily intake of 0.27 mg/rat, each rat weighing an avg. of 0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well characterized effects, consistent results among groups, only male reproduction toxicity was evaluated.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	2	2	2	Subchronic duration
Q_3	3	3	3	FEL based on reproductive effects
U	2	2	2	Only one dose, no NOAEL identified
M	0.5	0.5	0.5	Placed in drinking water
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	0.75	0.75	0.75	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: **Vanadium (Vanadyl sulfate)** CAS 27774-13-6

Test Organisms: Chicken (Omnivore, Order-Galliformes)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Kubena, L.F. and T.D. Phillips, 1982, "Toxicity of vanadium in female leghorn chickens," Poultry Science, 62:47-50.
QCE: 1.7 mg/kg-day — 25 ppm in diet converted to dose using an estimated 0.1 kg/day ingestion rate and 1.5 kg BW as indicated in study

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic study with adequate numbers of animals
Q_1	1	1	1	Endpoint ecologically relevant (growth and egg production)
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL
U	2	2	2	Multiple doses evaluated, good statistical analysis of data, but only weight and egg production were evaluated.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	1.7	1.7	1.7	QCE = quantified critical endpoint
TRV	0.43	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.43	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.14	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**FI=0.0582(BW)0.651 cited in EPA Wildlife Exposures Handbook

COPC: **Vanadium (Vanadyl sulfate)** CAS 27774-13-6

Test Organisms: Mallard (Herbivore, Order-Anseriformes)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: White, D.H. and M.P. Dieter, 1978, "Effects of dietary vanadium in mallard ducks. Journal of Toxicology and Environmental Health.
QCE: 1.0 mg/kg-day 10 ppm in diet converted to dose using 0.121 kg/day ingestion rate and 1.17 kg BW as indicated in study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic study with adequate numbers of animals
Q_1	0.5	0.5	0.5	Ecological relevance of endpoint questionable (altered lipid metabolism)
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint evaluated, multiple doses evaluated
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	1.0	1.0	1.0	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: **Vanadium (Vanadyl sulfate)** CAS 27774-13-6

Test Organisms: Mouse (Omnivore, Order-Rodentia)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Schroeder, H.A. and J.J. Balassa, 1967, "Arsenic, germanium, tin and vanadium in mice: Effects on growth, survival and tissue levels," Journal of Nutrition, 92:245-252.
ATSDR. Agency for Toxic Substance Disease Registry. 1990. Draft: Toxicological Profile for Vanadium. October, 1990.
QCE: 4.1 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	108 males and females tested
Q_1	1	1	1	Ecologically relevant endpoint (body weight gain)
Q_2	1	1	1	Chronic duration
Q_3	1	1	1	NOAEL
U	3	3	3	Older study, reproductive endpoints and sensitive life stage not examined,. Only one dose was tested, no LOAEL found.
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	1.37	0.68	0.46	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.37	Test organism is in the same order and trophic level as the functional group members	none
2	0.68	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: **Vanadium** (Ammonium metavanadate) CAS 7803-55-6

Test Organisms: Bovine (calves)
Exposure Medium: Gelatin capsule
Test Endpoint: NOAEL Clinical symptoms
Reference: Platonow, N. and H.K. Abbey, 1968, "Toxicity of Vanadium in Calves". *Vet. Record,* 82:292.
QCE: 7.5 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 young males
Q_1	1	1	1	Ecologically relevant endpoint.
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL
U	2	2	2	Older study, reproductive and sensitive endpoints not evaluated.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	7.5	7.5	7.5	QCE = quantified critical endpoint
TRV	0.94	0.47	0.31	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.94	Test organism is in the same order and trophic level as the functional group members	none
2	0.47	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.31	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: **Xylene** CAS 1330-20-7

Test Organisms: Mouse (Omnivore, Order-Rodentia)
Exposure Medium: Oral (gavage)
Test Endpoint: NOAEL
Reference: Marks, T., Ledoux, T., and Moore, J., 1982, "Teratogenicity of a Commercial Xylene Mixture in the Mouse", *J Toxi. Environ. Health*, 9:97.
QCE: 2.06 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females during gestation given the doses, no males or juveniles tested.
Q_1	1	1	1	Ecologically relevant endpoint (mortality/histopathologic effects)
Q_2	2	2	2	Subchronic exposure for pups (days 6-15 of gestation)
Q_3	1	1	1	NOAEL
U	2	2	2	Well designed study, 3 replicates done, sensitive life stage and reproductive endpoint tested but pup neurotox. and neurodevelopment are probably more sensitive endpoints.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	2.06	2.06	2.06	QCE = quantified critical endpoint
TRV	0.258	0.129	0.086	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.258	Test organism is in the same order and trophic level as the functional group members	none
2	0.129	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.086	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: **Xylene** CAS 1330-20-7

Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Oral (gavage)
Test Endpoint: NOAEL
Reference: National Toxicology Program (NTP), 1986, *NTP Technical Report on the Toxicology and Carcinogenesis of Xylene (Mixed) (60.2% m-Xylene, 13.6% p-Xylene, 17.0% Ethylbenzene, and 9.1%o-Xylene) (CAS No. 1330-20-7) in F344N/N Rates and B6C3F1 Mice (Gavage Studies),* NIH Publication No. 86-2583, Research Triangle Park, N.C.
QCE: 250 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adult males and females tested. No juveniles tested.
Q_1	1	1	1	Ecologically relevant endpoint (mortality/histopathologic effects)
Q_2	1	1	1	Chronic (103-week) exposure
Q_3	1	1	1	NOAEL
U	2	2	2	Well-designed study with adequate numbers of animals from two species tested. Comprehensive histology was performed. A LOAEL was not determined.
Total AF	4	8	12	R * I * Q_1 * Q_2 * Q_3 * U = Total AF
QCE (mg/kg-day)	250	250	250	QCE = quantified critical endpoint
TRV	62.5	31.3	20.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	62.5	Test organism is in the same order and trophic level as the functional group members	none
2	31.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	20.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:	**Zinc (zinc sulfate)** CAS 68813-94-5	
Test Organisms:	Chicken (Omnivore, Order-Galliformes)	
Exposure Medium:	Diet	
Test Endpoint:	LOAEL	
Reference:	Stahl, J.L., Greger, J.L., and M.E. Cook, 1990, "Breeding hen and progeny when hens are fed excessive dietary zinc," Poultry Science, 69:259-263. Hoadley, J.E., S.H. Tao, and M.R. W. Fox, 1989, "Dietary cadmium and zinc effects on peripheral neuromuscular development," 73rd Annual Meeting of the Federation of American Societies for Experimental Biology, New Orleans, LA., March 19-23, 1989, Federation of American Society for Experimental Biology, 4929.	
QCE:	12 mg/kg-day	20 mg/kg in diet converted to dose by 0.105 kg/day ingestion (from study) and 0.172 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic study with adequate number of animals
Q_1	1	1	1	Endpoint ecologically relevant (egg production)
Q_2	1	1	1	Chronic duration
Q_3	2	2	2	LOAEL
U	1	1	1	High quality study
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	12	12	12	QCE = quantified critical endpoint
TRV	6.0	3.0	2.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.0	Test organism is in the same order and trophic level as the functional group members	none
2	3.0	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433,AV442
3	2.0	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

COPC: **Zinc** CAS 7440-66-6

Test Organisms: Ferret (Carnivore, Order-Carnivora)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Straube, E.F., Schuster, N.H., and Sinclair, A.J., 1980, "Zinc toxicity in the ferret," Journal of Comparative Pathology, 90:355-361.

QCE: 142 mg/kg-day 500mg/kg*0.170kg/day/0.60kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	NOAEL group was only 3 animals
Q_1	1	1	1	Overall health, weight gain, hematological measurements, levels of zinc in organs
Q_2	2	2	2	Subchronic duration (48, 138 and 191 days)
Q_3	1	1	1	NOAEL
U	2	2	2	Adequate study design, but no reproductive endpoints examined.
Total AF	12	24	36	R * I * Q_1 * Q_2 * Q_3 * U = Total AF
QCE (mg/kg-day)	142	142	142	QCE = quantified critical endpoint
TRV	11.8	5.92	3.94	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	11.8	Test organism is in the same order and trophic level as the functional group members	M322
2	5.92	Test organism is in a different order and same trophic level from the functional group members	none
3	3.94	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422,M422A

COPC: **Zinc** CAS 68813-94-5

Test Organisms: Mallard (Herbivore, Order-Anseriformes)
Exposure Medium: Diet
Test Endpoint: LOAEL
Reference: Gasaway and Buss, 1972, "Zinc Toxicity in the Mallard Duck", *J. Wildl. Manage.* 36:1107-1117.
QCE: 207 mg/kg-day (3000mg/kg food)*(0.0363kg/day)/(0.525 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	15 males and 15 females tested, no juveniles
Q_1	1	1	1	Endpoint ecologically relevant (mortality, BW, and blood chemistry)
Q_2	2	2	2	Subchronic duration
Q_3	2	2	2	LOAEL
U	1	1	1	High quality study, but no NOAEL dose was found, all doses were toxic
Total AF	8	16	24	R * I * Q_1 * Q_2 * Q_3 * U = Total AF
QCE (mg/kg-day)	207	207	207	QCE = quantified critical endpoint
TRV	25.9	12.9	8.63	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25.9	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	12.9	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	8.63	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

*Ingestion rate specified in article, converted to ounces/10 days to kg/day

**BW estimated by interpolation of values given in the Wildlife Exposures Handbook and an average of 77% weight loss(given in article). 682*0.77=525 g

COPC: **Zinc (zinc oxide)** CAS 7440-66-6

Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Schlicker, S.A. and D.H. Cox, 1968, "Maternal dietary zinc and development and zinc, iron and copper content of the rat fetus," Journal of Nutrition, 95:287-294. ATSDR, Agency for Toxic Substance Disease Registry, 1988, Draft: Toxicological Profile for Zinc, December.
QCE: 170 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number (60) of females tested.
Q_1	1	1	1	Ecologically relevant endpoint (developmental effects)
Q_2	1	1	1	Chronic duration (36 days)
Q_3	1	1	1	NOAEL
U	2	2	2	Good design, reproductive endpoints and sensitive life stage examined, only 2 doses tested.
Total AF	4	8	12	R * I * Q_1 * Q_2 * Q_3 * U = Total AF
QCE (mg/kg-day)	170	170	170	QCE = quantified critical endpoint
TRV	43	21	14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	43	Test organism is in the same order and trophic level as the functional group members	none
2	21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:	**Cobalt (cobalt chloride)** CAS 7440-48-4	
Test Organisms:	Chicken (Omnivore, Order-Galliformes)	
Exposure Medium:	Diet	
Test Endpoint:	LOAEL	Increased mortality associated with *S. gallinarium* infection
Reference:	Hill, C.H., 1979, "The effect of dietary protein levels on mineral toxicity in chicks," Journal of Nutrition, 109:501-507.	
QCE:	10.2 mg/kg-day	100 ppm in diet converted to dose using an ingestion rate* of 0.02 kg/day and estimated body weight of 0.2kg from study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of animals, but variability not addressed.
Q_1	1	1	1	Endpoint ecologically relevant
Q_2	2	2	2	Subchronic duration
Q_3	2	2	2	LOAEL
U	2	2	2	No reproductive endpoints examined, but sensitive life stage evaluated
Total AF	16	32	48	R * I * Q_1 * Q_2 * Q_3 * U = Total AF
QCE (mg/kg-day)	10.2	10.2	10.2	QCE = quantified critical endpoint
TRV	0.638	0.319	0.213	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.638	Test organism is in the same order and trophic level as the functional group members	none
2	0.319	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.213	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

* Estimated as 0.0582 $Wt^{0.651}$ (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

COPC: **Cobalt** CAS 7440-48-4

Test Organisms: Dog (Omnivore, Order-Carnivora)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Brewer, B., 1940, "A statistical study of cobalt polycythemia in the dog," Am. J. Physiol. 128:345-348.
Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.
QCE: 5.0 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females tested, 7 total dogs.
Q_1	0.1	0.1	0.1	Endpoint of unknown ecological significance
Q_2	2	2	2	Subchronic duration (4 weeks)
Q_3	1	1	1	NOAEL
U	3	3	3	Older study, reasonable design, no reproductive endpoints or sensitive life stage examined.
Total AF	1.2	2.4	3.6	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	4.2	2.1	1.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.2	Test organism is in the same order and trophic level as the functional group members	M422A
2	2.1	Test organism is in a different order and same trophic level from the functional group members	M422
3	1.4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC: **Cobalt** CAS 7440-48-4

Test Organisms: Rat (Omnivore, Order-Rodentia)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Nation, J.R., Bourgeois, A.E., Clark, D.E. et al., 1983, "The effects of chronic cobalt exposure on behavior and metallothionein levels in the adult rat," Neurobehav. Toxicol. and Teratology, 5:9-15.
Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.
QCE: 5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Small number of male rats tested (18)
Q_1	1	1	1	Endpoint of relevant ecological significance
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable study, but sensitive life stage not examined
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	0.42	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.42	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:	**Vanadium (Vanadyl sulfate)** CAS 27774-13-6		
Test Organisms:	Chicken (Omnivore, Order-Galliformes)		
Exposure Medium:	Diet		
Test Endpoint:	NOAEL		
Reference:	Kubena, L.F. and T.D. Phillips, 1982, "Toxicity of vanadium in female leghorn chickens," Poultry Science, 62:47-50.		
QCE:	1.7 mg/kg-day	25 ppm in diet converted to dose using an estimated 0.1 kg/day ingestion rate and 1.5 kg BW as indicated in study	

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic study with adequate numbers of animals
Q_1	1	1	1	Endpoint ecologically relevant (growth and egg production)
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL
U	2	2	2	Multiple doses evaluated, good statistical analysis of data, but only weight and egg production were evaluated.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	1.7	1.7	1.7	QCE = quantified critical endpoint
TRV	0.43	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.43	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433,AV442
3	0.14	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**FI=0.0582(BW)0.651 cited in EPA Wildlife Exposures Handbook

COPC: **Vanadium (Vanadyl sulfate)** CAS 27774-13-6

Test Organisms: Mallard (Herbivore, Order-Anseriformes)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: White, D.H. and M.P. Dieter, 1978, "Effects of dietary vanadium in mallard ducks. Journal of Toxicology and Environmental Health.
QCE: 1.0 mg/kg-day — 10 ppm in diet converted to dose using 0.121 kg/day ingestion rate and 1.17 kg BW as indicated in study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic study with adequate numbers of animals
Q_1	0.5	0.5	0.5	Ecological relevance of endpoint questionable (altered lipid metabolism)
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint evaluated, multiple doses evaluated
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	1.0	1.0	1.0	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC: **Vanadium (Vanadyl sulfate)** CAS 27774-13-6

Test Organisms: Mouse (Omnivore, Order-Rodentia)
Exposure Medium: Diet
Test Endpoint: NOAEL
Reference: Schroeder, H.A. and J.J. Balassa, 1967, "Arsenic, germanium, tin and vanadium in mice: Effects on growth, survival and tissue levels," Journal of Nutrition, 92:245-252.
ATSDR. Agency for Toxic Substance Disease Registry. 1990. Draft: Toxicological Profile for Vanadium. October, 1990.
QCE: 4.1 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	108 males and females tested
Q_1	1	1	1	Ecologically relevant endpoint (body weight gain)
Q_2	1	1	1	Chronic duration
Q_3	1	1	1	NOAEL
U	3	3	3	Older study, reproductive endpoints and sensitive life stage not examined,. Only one dose was tested, no LOAEL found.
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	1.37	0.68	0.46	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.37	Test organism is in the same order and trophic level as the functional group members	none
2	0.68	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: **Vanadium** (Ammonium metavanadate) CAS 7803-55-6

Test Organisms: Bovine (calves)
Exposure Medium: Gelatin capsule
Test Endpoint: NOAEL Clinical symptoms
Reference: Platonow, N. and H.K. Abbey, 1968, "Toxicity of Vanadium in Calves". *Vet. Record,* 82:292.
QCE: 7.5 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 young males
Q_1	1	1	1	Ecologically relevant endpoint.
Q_2	2	2	2	Subchronic duration
Q_3	1	1	1	NOAEL.
U	2	2	2	Older study, reproductive and sensitive endpoints not evaluated.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	7.5	7.5	7.5	QCE = quantified critical endpoint
TRV	0.94	0.47	0.31	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.94	Test organism is in the same order and trophic level as the functional group members	none
2	0.47	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.31	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

COPC: **Benzene** CAS 71-43-2

Test Organisms: Mouse (Omnivore, Order-Rodentia)
Exposure Medium: Oral (gavage)
Test Endpoint: LOAEL
Reference: Nawrot, P.S. and R.E. Staples. 1979. "Embryofetal toxicity and teratogenicity of benzene and toluene in the mouse." *Teratology*. 19: 41A.

QCE: 263.6 mg/kg-day [0.3mL Benzene/kg BW * 0.8787 g Benzene/mL Benzene * 1000mg/g] = 263.6 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	days 6-12 of gestation
Q_1	1	1	1	Ecologically relevant endpoint (reproduction).
Q_2	3	3	3	Short duration
Q_3	2	2	2	LOAEL
U	2	2	2	Three dose levels, exposure at highest two doses (0.5 and 1.0 mL/kg/d significantly increased maternal mortality and embryonic resorption. Fetal weights were significantly reduced by all three dose levels.
Total AF	24	48	72	R * I * Q_1 * Q_2 * Q_3 * U = Total AF
QCE (mg/kg-day)	263.6	263.6	263.6	QCE = quantified critical endpoint
TRV	10.98	5.49	3.66	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	10.98	Test organism is in the same order and trophic level as the functional group members	none
2	5.49	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.66	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC: **Benzene** CAS 71-43-2

Test Organisms: Mouse and Rat (Omnivore, Order-Rodentia)
Exposure Medium: Oral (gavage)
Test Endpoint: FEL
Reference: National Toxicology Program (NTP), 1986, *Toxicology and Carcinogenesis Studies of Benzene in F344/N Rats and B6C3F Mice (Gavage Studies)*, NTP Technical Report Series No. 289, NIH Publication No. 86-2545.
QCE: 25 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No juveniles of either species tested.
Q_1	1	1	1	Ecologically relevant endpoint
Q_2	1	1	1	Long-term (103-week) study
Q_3	3	3	3	FEL
U	2	2	2	Numerous other studies exist to support these findings. Adequate number of animals from both sexes of the two species tested.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U$ = Total AF
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	2.1	1.0	0.69	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.1	Test organism is in the same order and trophic level as the functional group members	none
2	1.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.69	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322